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Emissions Model for Ground Support Equipment: USER'S GUIDE

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16 Abstract

This report describes how to change Ground Support Equipment (GSE) input parameters of the Emission and Dispersion Model System (EDMS) (Segal, H M) to reflect "what if" investigations associated with GSE equipment changes EDMS is a pc-based air quality impact assessment tool for airports and airbases The GSE extension adds the capability to estimate, inventory, and report emissions from diesel and gas-powered support equipment, such as generators, fuel trucks, air conditioners, and bomb lifts This user's guide provides a brief overview of GSE hardware and operations It also demonstrates how to use GSE options by guiding the reader through a sample problem which adds a new GSE source to the list of GSE's and links the new GSE source to a specific aircraft

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1 - INTRODUCTION

The Federal Aviation Administration's Emission and Dispersion Model System (EDMS) contains default Ground Support Emissions (GSE) assignments, factors, and operating times. These are considered "reasonable" estimates, sufficient for most routine airport improvement analyses However, some users may want to modify these numbers in order to support other investigations The purpose of this document is to describe how the GSE fields can be altered to perform "what if" analysis for promising new technology.

Table 1 lists the GSE that has been incorporated into EDMS The function of each GSE type is described below and referenced in Table 1.

GSE GROUPS

1.1 AIRCRAFT OPERATION

There are a number of services which must be performed while the aircraft is on the ground during a landing takeoff (LTO) cycle. The ones described below are required for safe operation of the aircraft.

1.1.1 PUSHBACK

Although some aircraft can back away from the gate using engine reverse thrust, there are advantages in using a large capacity tractor to perform this back-up operation The tractors that would perform this task are usually diesel powered

1.1 2 MAINTENANCE

Military aircraft receive a significant amount of scheduled maintenance on the ramp both pre-and post-mission The base operations personnel should be able to provide information on the vehicles used to perform this aircraft maintenance

1.1.3 FUEL

Fuel Trucks are in use at most civilian airports They either transport fuel to the aircraft or pump fuel from a fuel hydrant located near the gate or parking area. Some facilities have stationary pumps located at the hydrants

1 1.4 COMPRESSED AIR

Compressed air can be either low or high pressure. Low pressure air can substitute for engine bleed air when the engines are not running. This can drive air conditioning packs on the aircraft. High pressure air may be required by a number of aircraft systems Low pressure compressed air has a number of uses, including engine starting. A compressed air source used for engine starting is called an airstart unit The airstart unit normally requires a transporter to tow it to and from the aircraft. There is a trend toward diesel power for these airstart unit tractors

TABLE 1

GSE Types By Group

		GSE GROUPS		
GSE INDEX #	GSE NAME	AIRCRAFT OPERATION	PASSENGER SERVICE / CREW SUPPORT	CARGO
1	H1 heater		1.2 1	
2	1H1 heater		1.2 1	
3	MA3 cooler		1 2 1	
4	MD3 generator	1 1 5		
5	90G20P generator	1 1.5		
6	AN32A60A generator	1 1.5		
7	MC1A compressor	1 1 4		
8	MC11 compressor	1 1 4		
9	MC2A compressor	1 1.4		
10	1MC1A compressor	1 1 4		
11	MA1A compressor	1 1 4		
12	TTU228E hydraulic test stand	1 1 2		
13	MJ1 hydraulic test stand	1 1 2		
14	MJ2A hydraulic test stand	1 1 2		
15	TTU228E1B hydraulic test stand	1 1 2		
16	MJ1 bomblift			1 3 2
17	MJ1A bomblift			1 3 2
18	MHU83AE bomblift			1 3 2
19	HF2 pressure tester	1 1 2		
20	M32T1 pressure tester	1 1 2		
21	M27M1 jacking manifold	1 1 2		
22	Gas tractor		1 2 4	
23	Diesel tractor		1 2 4	
24	Gas belt loader		1 2 4	
25	Diesel belt loader		1 2 4	
26	Gas container loader			1 3 1
27	Diesel container loader			1 3 1
28	Gas cabin service		1 2 5	
29	Diesel cabin service		1.2 5	
30	Gas lavatory truck		1 2 2	
31	Diesel lavatory truck		1 2.2	
32	Gas water truck		1 2.2	
33	Diesel water truck		1 2 2	
34	Gas food truck		1 2 3	
35	Diesel food truck		1 2 3	
36	Gas fuel truck	1 1 3		
37	Diesel fuel truck	1.1 3		
38	Gas aircraft tractor	1 1 1		
39	Diesel aircraft tractor	1 1 1		
40	Gas air conditioner		1 2 1	

TABLE 1

GSE Types By Group (cont)

GSE INDEX #	GSE NAME	GSE GROUPS		
		AIRCRAFT OPERATION	PASSENGER SERVICE / CREW SUPPORT	CARGO
41	Diesel air conditioner		1.2 1	
42	Gas airstart transporter	1 1 4		
43	Diesel airstart transporter	1 1 4		
44	Gas airstart	1 1 4		
45	Diesel airstart	1 1 4		
46	Gas GPU transporter	1 1.5		
47	Diesel GPU transporter	1 1.5		
48	Gas GPU	1.1 5		
49	Diesel GPU	1 1 5		
50	Gas transporter		1 2 6	
51	Diesel transporter		1 2 6	
52	GTCP85-98CK (APU)	1 1 4, 1 1 5	1 2 1	
53	GTCP85-129 (APU)	1 1 4, 1.1 5	1 2 1	
54	GTCP660-4 (APU)	1 1 4, 1 1 5	1.2 1	
55	TSCP700-4 (APU)	1 1.4, 1 1 5	1.2 1	
56	ST6C (APU)	1 1 4, 1 1.5	1 2 1	
57	GTCP85-98 (APU)	1 1 4, 1 1 5	1 2 1	
58	GTCP85-115 (APU)	1 1 4, 1 1 5	1 2 1	

GSE types

1 1.1 - PUSHBACK	1.2 2 - WATER AND LAVATORY
1.1.2 - MAINTENANCE	1 2.3 - FOOD AND DRINK
1.1.3 - FUEL	1 2.4 - BAGGAGE
1 1.4 - COMPRESSED AIR	1.2.5 - CABIN CLEANING
1.1 5 - ELECTRICITY	1.2 6 - PASSENGER TRANSFER
1.1 6 - DEICING	1.3.1 - LOADING AND UNLOADING
1.2.1 - HEATING AND COOLING	1.3.2 - MILITARY STORES

1.1 5 ELECTRICITY

Aircraft standby electricity is provided either by hooking to a dedicated airport electrical source at a fixed airport location or to a Ground Power Unit (GPU) which is usually towed to the aircraft with a tractor or transporter. Power can also be provided from an on-board Auxiliary Power Unit (APU)

1.1.6 DEICING

Federal regulations require that a civil aircraft cannot take off with snow or ice adhering to the wings or control surfaces Winter weather conditions may require the spraying of the aircraft with heated deicing fluid while it is on the ground in order to remove existing ice and prevent the accumulation of additional ice. (A deicer GSE unit is presently not accommodated in the model).

1.2 PASSENGER SERVICE / CREW SUPPORT

There are a number of services which must be performed for the comfort of passengers or crew during the interval while the aircraft is parked Some of these tasks involve the replenishment of supplies used in fight, others provide for comfort during the ground interval.

1.2 1 HEATING AND COOLING

When an aircraft is parked with the engines off, there is usually a need to maintain cabin and cockpit air temperatures at a comfortable level This may be accomplished either with the aircraft's onboard APU (if fitted), or with ground heating and cooling units. In cold climates, heaters are also used to warm engines and instruments in order to facilitate starting and minimize wear

1.2 2 WATER AND LAVATORY

Lavatory trucks have vacuum pumps which can quickly drain the aircraft's lavatory holding tanks. Water trucks replenish potable water. These small trucks are either gasoline or diesel powered

1.2.3 FOOD AND DRINK

Aircraft catering operations typically use a truck with a hydraulic scissors mechanism to raise and lower the cargo carrying part of the truck These are a mix of gasoline and diesel units

1.2.4 BAGGAGE

Tractors tow baggage carts to and from the aircraft while it is at the gate or parking area. Belt loaders are mobile conveyor belts which move bags on or off the aircraft The 305 HP Ford 305 gasoline engine is commonly used for both.

1.2.5 CABIN CLEANING

Before an airliner takes on a new load of passengers, a cleaning crew may be sent into the aircraft to prepare the cabin. This is accomplished with use of a small truck which is usually gasoline powered.

1.2.6 PASSENGER TRANSFER

A final category of passenger-related ground support equipment is the transporter These are vehicles used to transport passengers to outlying terminals or from gates to aircraft parking areas. The mobile lounges at Dulles International and the shuttle buses used by COMAIR at Cincinnati are two examples.

1.3 CARGO

Much air cargo is carried as "belly cargo" aboard scheduled passenger flights Other cargo is carried in all-cargo flights aboard air freight carriers Much of the cargo transporting tractors are diesel powered.

1.3.1 LOADING AND UNLOADING

Aircraft cargo is typically carried in large cargo containers which are raised and lowered to and from the aircraft with container loaders. These units typically employ a hydraulic scissors jack to raise and lower the containers.

1.3.2 MILITARY STORES

Specialized military missions require other equipment Base operations personnel can provide information on the amount of use per landing/takeoff (LTO) cycle.

2 - EXAMPLE PROBLEM

The example problem is set at Washington National Airport (DCA) and is an expansion of the Ground Support Equipment (GSE) emissions processing portion of the EDMS model. Before processing any further with the GSE model the example problem listed in the User's Guide of the basic EDMS model must be executed.

The example problem shows how to add a new GSE item to the GSE database and how to assign this item to an aircraft. The example problem incorporates some special notations. The word ENTER in the text means that the carriage return key (↵) should be pressed. Text entries must be in upper case. Quotes around numbers, characters, or words are for identification purposes only. They are not to be typed in.

2.1 ACCESSING EDMS

STEP	ACTION	PURPOSE
1	turn on computer, monitor and printer	activate system
2	press CAPS LOCK key	set for upper case entry
3	type "CD\EDMS793" ENTER	change to the EDMS directory
4	type "EDMS" ENTER	execute EDMS program within the EDMS directory
5	type "1" ENTER	select sources - data menu
6	type "1" ENTER	select aircraft source
7	type "2" ENTER	select GSE source

2.2 ADD A NEW GSE

This part shows you how to add a new GSE.

8	type "3" ENTER	select "ADD" from "EMISSION RATES PARAMETER" option
9	enter data from Table 2.	
	Note: Values for FIXED ANNUAL COST and HOURLY COST are obtained by the user and are optional.	
10	type "E"	save the entered data and return to "GROUND SUPPORT EQUIPMENT (GSE)" screen

TABLE 2

GSE Emission Rates

GROUND SUPPORT EQUIPMENT (GSE) EMISSION RATES (GSEF)

INDEX# 59

NAME Test Unit

emission rate kg/hr

CO	.699301
HC	.156251
NOX	.039912
SOX	.000546
PART	.001260

Equipment Cost per Aircraft -- (OPTIONAL)

FIXED ANNUAL COST $ 0.00 <-- insurance, interest and purchase price.

HOURLY COST $ 0.00 <-- cost of fuel, personnel and maintenance.

TOTAL ANNUAL COST $ .00 (calculated)

2.3 ATTACHING A GSE TYPE TO AN AIRPLANE

This part shows you how to add a newly GSE unit to the group of GSE's assigned to a 727.

11	type "1" ENTER	select "ADD" from "GROUND EQUIPMENT TIME" option
12	enter data from Table 3.	
13	type "E"	save the entered data and return to "GROUND SUPPORT EQUIPMENT (GSE)" screen
14	type "11" ENTER	return to main menu

TABLE 3

GSE Engine Operating Time

GSE NAME, GSE TIME, AND AIRCRAFT IT IS ASSIGNED TO
INDEX# 59
NAME Test Unit
AIRCRAFT 727
GROUND EQUIPMENT TIME 10 00 (min / LTO)

2.4 RUNNING EMISSION MODEL

15	type "5" ENTER	select emissions model menu
16	type "1" ENTER	run emissions model and check for errors
17	type "2" ENTER	print emission report (see Appendix A3)
18	type "11" ENTER	return to main menu

3 - CALCULATING GSE EMISSIONS PER LTO

Example:

To calculate Carbon Monoxide (CO) emissions (grams / LTO) for a gas tractor used with a 707 aircraft where the GSE fuel flow is 1 80 (gal/hr) and the CO emission index is 2 2024 lb/gal and the equipment operating time is 20 minutes, the following equation would apply:

FUEL FLOW	*	EMISSION INDEX	*	GROUND EQUIPMENT TIME	*	UNIT CONVERSION FACTOR	=	GSE EMISSIONS
1 8	*	2.2024	*	20	*	7.5607	=	599.465

* FUEL FLOW and EMISSION INDEX values were extracted from Table IV-3 and IV-5 of (FAA 1982).

REFERENCES

FAA 1982; Air Quality Procedures for Civilian Airports and Air Force Bases; Federal Aviation Administration, Washington, D. C. 20591; Report # FAA-EE-82-21 ESL-TR-82-23; December 1982

Segal H M ; EDMS - Microcomputer Pollution Model for Civilian Airports and Air Force Bases User's Guide, Federal Aviation Administration, Washington, D C. 20591, Report # FAA-EE-91-3, ESL-TR-91-31; June 1991 (with Supplement A)

APPENDIX A

Two emissions inventories are reported. The first reports the emissions of all airport sources processed in the basic EDMS. (In this report the GSE emissions are calculated from default values in the GSE data input fields.) The second reports the same information form all sources except for the GSE source where the defaults have been supplemented with a new values associated with new GSE item 59.

EMISSION REPORT
(all values are in grams/year)

	CARBON MONOXIDE	HYDROCARBONS	NITROGEN OXIDES	SULPHUR OXIDES	PARTICULATES
ROADWAYS	1.457E+08	1.057E+07	4.948E+06	2.840E+03	1.885E+04
VEH. PARKING	2.553E+07	1.818E+06	5.577E+05	2.682E+02	1.780E+03
POWER PLANTS	1.052E+08	1.929E+06	1.140E+08	6.837E+08	2.805E+08
GRND. SUP. EQU.	5.506E+08	1.214E+08	1.002E+08	2.156E+06	6.230E+06
AIRCRAFT	2.371E+09	5.648E+08	1.744E+09	1.173E+08	0.000E+00
GRAND TOTAL	3.198E+09	7.005E+08	1.964E+09	8.032E+08	2.868E+08

EMISSION REPORT
(all values are in grams/year)

	CARBON MONOXIDE	HYDROCARBONS	NITROGEN OXIDES	SULPHUR OXIDES	PARTICULATES
ROADWAYS	1.457E+08	1.057E+07	4.948E+06	2.840E+03	1.885E+04
VEH. PARKING	2.553E+07	1.818E+06	5.577E+05	2.682E+02	1.780E+03
POWER PLANTS	1.052E+08	1.929E+06	1.140E+08	6.837E+08	2.805E+08
GRND. SUP. EQU.	5.626E+08	1.241E+08	1.009E+08	2.166E+06	6.251E+06
AIRCRAFT	2.371E+09	5.648E+08	1.744E+09	1.173E+08	0.000E+00
GRAND TOTAL	3.210E+09	7.031E+08	1.965E+09	3.032E+08	2.868E+08